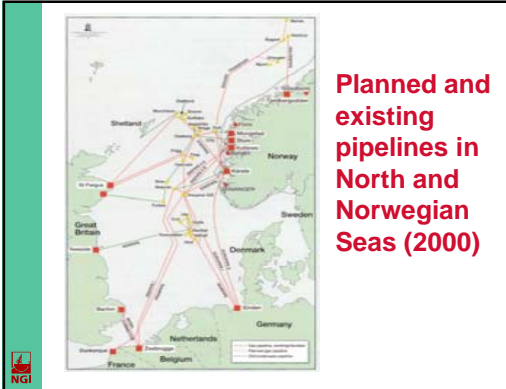
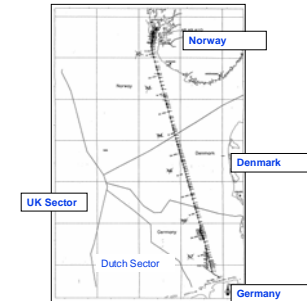


**Case history : Europipe from Sleipner in Norwegian Sector of North Sea to Nordeney in Germany**

- Offshore part
- Nearshore/onshore part w/tunnel



**North Sea Pipeline(Europipe) from Norway to Germany**



**Europipe II pipeline Norway to Germany : Offshore part**

**Project information**

- Length of pipeline : 650 km
- Offshore part : water depth : 26 - 373 m
- Crossing Norwegian, Danish and German sectors
- In parts requirement to bury pipeline to 3 m
- Information required for trenching and pipe/soil interaction



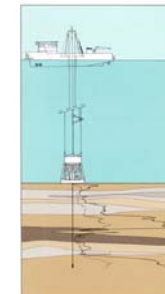
**Europipe II pipeline Norway to Germany**

**Soil investigation program:**

- 135 testing stations penetration 3 - 4 m
- CPTUs at all locations
- Sampling at selected locations
  - Gravity cores in soft clay
  - Vibrocores in sand and stiff clays
- Dynamic positioned ship
- Production up to 25-30 stations per 24 hours



**Fugro's wheeldrive CPT system used for offshore part of investigation**

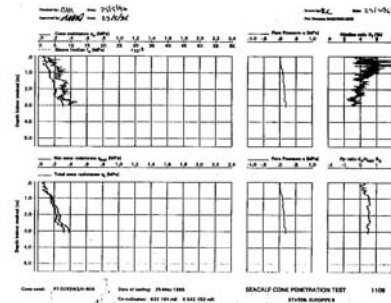


Heavy duty rig  
20 t, profiling  
to 45-50 m  
penetration  
possible

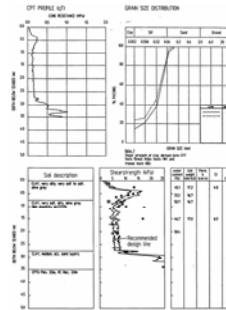
From brochure



## Example CPTU profile Europipe soil investigation



## Integrated results of CPTU and laboratory tests on vibrocore sample, Europipe



## Europipe recommended soil parameters to be used from KP 134.7 to KP 201.6

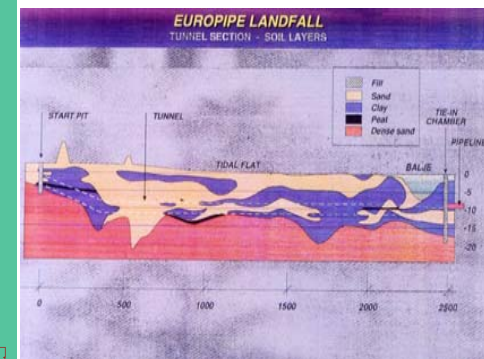
Unit	Top	Bottom	Soil description	Water cont.	Total unit weight	Friction angle	$s_u$ top	$s_u$ bottom	$N_c$	$M$	$K_a$	Pen	$D_{50}$
1	0	0.5	CLAY, very soft, very high plasticity	85-120	14.5	20	4	2.4	0.5-1.6	0.5	1.1	20-40	0.005
II	0.5	1	CLAY, soft to medium	40-70	16	30	17	4.6	16-3	1	1.5	10-20	0.006

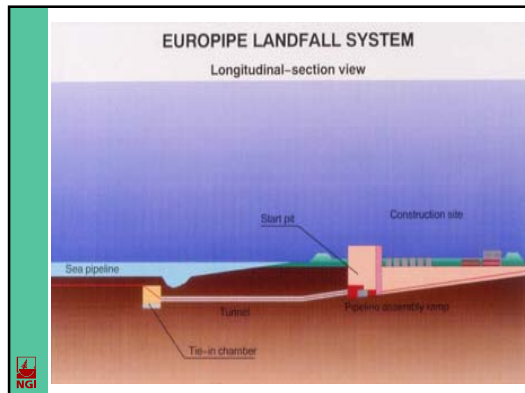
LEGEND  
 $s_u$  = undrained shear strength  
 $N_c$  = sensitivity  
 $M$  = constrained deformation modulus  
 $K_a$  = coefficient of earth pressure at rest  
 $D_{50}$  = the size such that 50% of sample consist of particles having a smaller nominal diameter  
 Numbers in parenthesis show the variation

## Eoropipe Landfall Tunnel

- Environmental considerations led to requirement for 2535 m long tunnel from inside main dyke underneath a national wetland park and out to sea
- Soils deposited after last ice age : loose to medium dense fine sands, silts, soft to medium stiff clays and peat
- Identification of peat very important for the tunnel construction

## Europipe landfall area





## Europipe landfall tunnel

### Soil investigation strategy:

- In National park area only CPTs permitted
- Soil sample boreholes : 8
- CPTUs : 100



## Europipe landfall tunnel

### Soil investigation strategy:

- In National park area only CPTs permitted
- Soil sample boreholes : 8
- CPTUs : 100

Identification of peat layers from CPTU profiles on very important aspect



## Roson rig with one set of roller wheels



5 ton rig for pipeline investigations with standard size cones

From AP van den Berg brochure



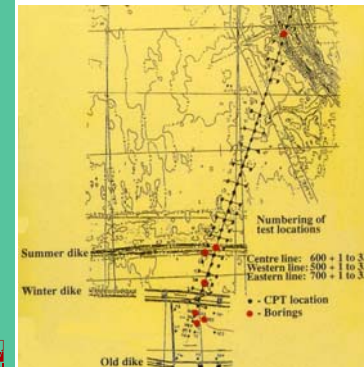
## Europipe soil investigation



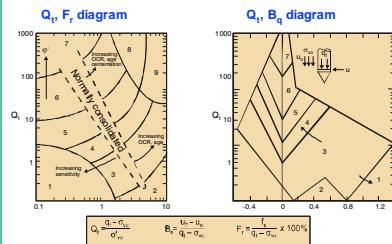
## Europipe soil investigation



## Europipe soil investigation

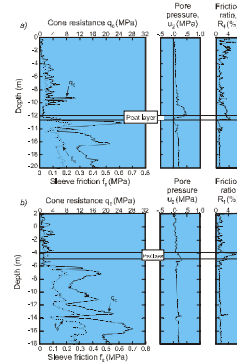


## Normalized soil behaviour classification chart

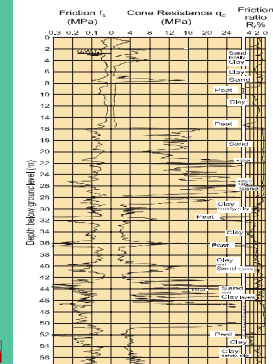


Zone	Soil behaviour type	Zone	Soil behaviour type	Zone	Soil behaviour type
1	Sensitive, fine grained	4	Silt mixtures clayey silt to silty clay	7	Gravelly sand to sand
2	Organic soils peats	5	Sand mixtures, silty sand to sand silty	8	Very stiff sand to clayey sand
3	Clays, clay to silty clay	6	Sands, clean sands to silty sands	9	Very stiff fine grained

Robertson, 1990



Example of  
CPTU profiles  
from coast of  
Germany with  
peat layers



Example of  
CPT profile  
from Holland  
with peat  
layers

Vos (1982)

## Europe soil investigation

- Scheme with large number of CPTUs and a few selected soil borings is very efficient and can give reliable soil profiles and soil design parameters
- Identification of special problematic soils can be successfully done with CPTU profiling